

SYLLABUS: PHZ 7427, **Physics of Solids II**

Spring 2022

Instructor: Peter Hirschfeld, NPB 2156, interests in superconductivity and strongly interacting electronic systems.

Office Hours : M 4pm, W 4pm; or just drop in—I will try to make time to discuss if I am free.

Course description: Physics of collective phenomena in condensed matter systems: electron-electron and electron-phonon interactions, superconductivity, magnetism and quantum transport.

Prerequisites: PHZ6426 or equivalent course covering fundamentals of 1-electron theory of solids.

Recommended Texts: None

Supplementary Texts

- C. Kittel, *Quantum Theory of Solids*, New York: John Wiley 1987
- N. Ashcroft and N.D. Mermin, *Solid State Physics*, Philadelphia:Saunders College, 1976.
- G. Mahan, *Condensed Matter in a Nutshell*, Princeton: Princeton U. Press, 2011.
- P. Phillips, *Advanced Solid State Physics*, Boulder: Westview Press, 2003.
- S. Blundell, *Magnetism in Condensed Matter*, New York: Oxford, 2001.
- N. H. March and W. Jones, *Theoretical Solid State Physics* , New York: Wiley, 1973 (Dover Paperbacks!)
- A.A. Abrikosov, *Fundamentals of the Theory of Metals*, New York: Elsevier, 1988
- J.M. Ziman, *Principles of the Theory of Solids*, Second edition (Cambridge University Press, 1972)
- O. Madelung, *Introduction to Solid-State Theory*, (Springer-Verlag, 1978).
- M. Tinkham, *Introduction to Superconductivity*, Third edition, (Dover, 2004).
- P. Misra, *Physics of Condensed Matter*, San Diego: Academic Press 2012.

Required Work: ~6 Problem Sets (40%), Midterm (20%), Final (25%), 1 30-min Journal club presentation (15%).

Course Website: http://www.phys.ufl.edu/~pjh/teaching/phz7427/7427_S22_index.html

UF Covid-19 policy: <https://coronavirus.ufl.edu/>

Week(s)	Topic(s)	Read (notes +...)	Homework	Remarks
Jan. 3 Jan. 10	<i>I. Second Quantization</i> 1. Free Fermi gas 2. Phonons	Misra pp. 53-60, Kittel Ch. 2, AM Chs. 2-4,22-24	Prob. Set 1	
Jan. 17 Jan. 24	<i>II. Electron-electron interactions</i> 1. Screening in electron gas 2. Plasma oscillations 3. Fermi liquid theory 4. Failures of band theory	Misra Ch. 7, Kittel Ch. 3, AM Ch. 17	Prob. Set 2	1/17 MLK Day
Jan. 31 Feb. 7 Feb. 14	<i>III. Magnetism</i> 1. Para/diamagnetism of single ions 2. Origin of magnetic exchange 3. Magnetic ordering 4. Magnons in ferro- and antiferromagnets 5. Magnetic neutron scattering 6. Itinerant magnetism/ Hubbard model 7. Kondo problem	Misra Chs. 12-13, AM Chs. 31-33, Kittel Ch. 4	Prob. Set 3	JClub abstracts due Feb. 14
Feb. 21	<i>IV. Electron-phonon interactions</i> 1. Coulomb screening of ionic plasmon 2. Resistivity of metals/ Umklapp 3. Effective electron-electron interaction	Misra Sec. 8.11, AM Ch. 26, Kittel Ch. 7	Prob. Set 4	Midterm 2/23 (in-class)
Feb. 28 Mar. 7 Mar. 14 Mar. 21 Mar. 28	<i>V. Superconductivity</i> 1. Phenomenology/ London theory 2. BCS theory 3. Ginzburg-Landau theory 4. Magnetic properties 5. Josephson effect	Ch. 14, Kittel Ch. 8. AM Ch. 34	Prob. Set 5	Spr. Brk. 3/5-12 PH gone 3/14-18 Class cancelled (APS mtg.)
Apr. 4 Apr. 11 Apr. 18	<i>VI. Topological States in CM</i> 1. Topo. insulators 2. Edge states 3. Topo. Superconductors	Qi-Zhang RMP 83, 1057.	Prob. Set 6	
Apr. 21-24	<i>Final exam</i>	All	None	Take-home